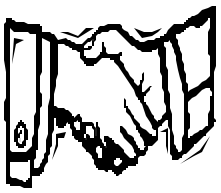
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604
EPA 905-F-00-028
August 2000

TECHNICAL FACT SHEET FOR CADMIUM

Cadmium is one of the PBT chemicals identified as a priority. Cadmium is released into the environment through mining and metal processing operations, burning fuels, making and using phosphate fertilizers, and disposing of metal products. One of the reasons that cadmium has been listed as a PBT is that inhaling cadmium fumes at high exposures can cause heart and lung irritation, including shortness of breath, chest pain, coughing, and a buildup of fluid in the lungs. Cadmium is considered to be toxic, and is a probable cancer-causing agent in humans. It is believed that cadmium can have toxic effects on the prostate, kidney, lung and testes, and may also affect the female reproductive cycle.

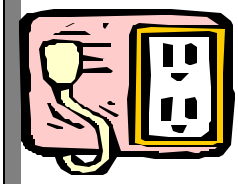
EPA PARTNERSHIP AND YOU...



The United States Environmental Protection Agency (EPA) has identified numerous persistent, bioaccumulative and toxic (PBT) chemicals that may be present in some industrial hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA). In addition to its ongoing regulatory activities, EPA will focus voluntary efforts on actions that reduce the generation of these PBT chemicals. EPA will also work with states, industry, and environmental groups through workshops, technical assistance programs, partnership agreements, regulatory reinvention projects, and other strategies to promote progress toward the goal of reducing the generation of RCRA PBT's in hazardous waste by 50 percent by the year 2005.

THE CADMIUM CONNECTION

Even though cadmium is extremely toxic and regulated by the EPA, large amounts of cadmium are still utilized in a range of applications by a variety of industries. Because of its regulatory status and the higher costs of cadmium, many industries are looking for less hazardous alternatives. Most cadmium used in the United States is a soft metal or powder obtained as a by-product from the treatment of copper, lead and iron ores.



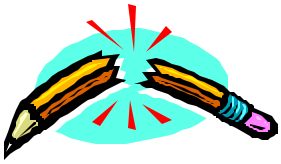
Here are just a few of the uses for cadmium:

- Plating metal parts
- Fertilizers
- Plastic stabilizers
- Batteries

Here are some of the industries that may use cadmium:

- Manufacturers of fabricated metal parts
- Manufacturers of plastics
- Manufacturers of paints and pigments
- Manufacturers of alloys, chemical reagents and/or intermediates
- Manufacturers of fertilizer

BREAKING THE TIE WITH CADMIUM



There are several different alternatives and processes that are available to eliminate or reduce the amount of cadmium used in manufacturing operations. When a company decides to modify their process operations to reduce or eliminate cadmium, the facility should evaluate these different processes and test several applications to determine what method would best fulfill its needs. Listed below are several replacement or reduction alternatives for cadmium:

Aluminum Ion Vapor Deposition System (AIVD): The AIVD system can be used in place of cadmium in the electroplating industry. The major components of an AIVD system are comprised of an IVD vacuum chamber, a positive pressure clean room, a two-stage vacuum pump system, a cryogenic cooler and a parts rack with air-flotation transport dollies. By changing to an AIVD system, no hazardous materials will be required in coating operations and no hazardous waste will be generated. Some other advantages by switching to an AIVD system are that in acidic environments, AIVD prevents corrosion better than cadmium coatings, AIVD coatings stand up to higher temperatures and AIVD allows for a thicker and more uniform coating on the parts. AIVD is a technology that can replace cadmium in many different applications. AIVD can be used to apply coatings of aluminum to metal, plastic, composites and other substrates.

Reverse Osmosis and Closed Loop System: In manufacturing operations where cadmium waste is produced, a reverse osmosis filter system can be used to filter out the cadmium from process wastewater. For example, a company that used zinc metal powder, along with cadmium chloride salt produced by-products of zinc chloride and a cadmium powder. The cadmium powder was removed by the reverse osmosis system, while the zinc chloride was used for other production purposes. A closed loop system was then installed which recycled the wastewater produced and fed the water back into production processes as clean-up water. One disadvantage of reverse osmosis systems is the clogging of the filter membrane with solid particles. Yet, this can be alleviated in most cases by simply adjusting the pH of the water which will hinder precipitation and therefore eliminate the solids from obstructing the filter.

Non-Cadmium Based Pigments: Many types of cadmium-free pigments are available today for use in industry. One example of a cadmium-free pigment was created by combining an alloy of polycarbonate and acrylonitrile-butadiene styrene terpolymer (ABS). The new cadmium-free formula passed a 1000-hour UV-ray exposure test, equivalent to three years' exposure to the sun. By switching to cadmium-free pigments, it may also be possible to reclassify the waste stream as non-hazardous, depending on the alternative used.

Zinc-based Replacements: A variety of zinc-based chemistries can be substituted for cadmium in the electroplating industry. A few of the more common zinc-based alternatives that may be used to replace cadmium are described in more detail below.

- Zinc-Nickel Alkaline: This alternative provides good corrosion properties after parts-forming operations and heat treating and produces uniform thickness during coating processes, but a chiller is required to maintain optimum temperature conditions. This substitute produces a deposit that tends to favor applications that do not require bend-ability.

- Zinc-Cobalt Acid: The plating bath for this alternative has a high cathode efficiency and a high plating speed, but has variable current density.

Tin-based Replacements: There are also a several of tin-based electroplating options available to replace cadmium. A few of the more common tin-based substitutes are described below in more detail.

- Tin-Nickel Acid or Near Neutral: This option has a good resistance to corrosion and tarnish and also has good ductility. The finish on the coated materials can also be very decorating in appearance.

- Tin-Zinc Acid, Alkaline or Neutral: The tin-zinc alternatives have good corrosion protection with chromate applied and do not undergo bimetallic corrosion. The finish has a fair appearance, yet with excellent ductility.

MEASURE YOUR SUCCESS

Many companies have benefitted by replacing cadmium in their process or product, and simply using the available environmentally friendly alternatives or recycling and reusing cadmium in production processes. Here are some stories for several companies that have successfully implemented cadmium-reduction methods in their operations:

- A manufacturer that produces batteries was creating significant amounts of cadmium powder as a by-product (along with other metals) in production processes. By installing a reverse osmosis membrane system in place of the heat treatment system, the metals can be recovered and reused instead of discharged with wastewater. The capital cost for this equipment was under $50,000 and the payback period was approximately six months.

- A metals processing company installed an electro-winning unit on their electroplating line due to dragout contributing to high metals contamination in wastewater. The results were lower water use, zero discharge to the wastewater treatment system and filter cake disposal with no adverse impacts on product quality. The capital cost for this unit was $9,000 with a savings of over $1,500 per year.

- Another plating company eliminated cadmium and substituted a zinc-cobalt solution in its operations. Changing solutions did not require any additional equipment, but eliminated an entire process from waste treatment operations. The estimated savings for this company was $35,000 per year.

- An Army Depot installed aluminum iron vapor deposition equipment in their facility to assist in the reduction of the amount of cadmium used during plating processes. The project reduced cadmium by over 50 percent and would, in time, increase that to 80 percent. The system also reduced the generation of hazardous waste by over 4,300 pounds per year. The equipment cost was $848,000, but the first year of savings in operational costs was over $1,000,000.

- A company discontinued the use of cadmium-based pigments by substituting a non-cadmium based pigment in its process operations. By doing so, this company was able to reclassify their waste stream as a non-hazardous waste which then eliminated approximately 38,000 pounds of waste per year, with an estimated annual savings of $10,000.

FOR MORE INFORMATION...

There are various resources to locate more information on the substitution and potential elimination of cadmium from your workplace. Here a just a few of the Web sites available via the Internet and the government agency listings that would be able to provide more information.

Web sites

- www.epa.gov/osw/index.htm
- .es.epa.gov/program/regional/state/wi/rayovac.html (Envirosense)
- www.oznet.ksu.edu/dp_nrgy/ppi/publications/manual/MetalFinish/section3.html
- nuclear.hazard.uiuc.edu/packets/finishing/plating.htm
- p2.utep.edu/casestudies/corparm195.htm
- www.elna-america.com/DLC-battery.htm
- www.goldenpaints.com/cadmiums.htm
- aec.army.mil:8080/prod/usaec/et/pp/ion.htm
- www.epa.gov/iris/subst/0141.htm
- www.aaplating.com/ivd-info-envir.htm
- es.epa.gov/techinfo/facts/epa/metlfnsh.htm(Envirosense)
- www.nsc.org/ehc/ew/chems/cadmium.htm
- www.globar.com/maxcap.html
- www.epa.state.oh.us/opp/gov/fact17.html
- www.pwrc.usgs.gov/new/chrback.htm

Government Listings

U.S. EPA Region 5
P2 Hotline
⇨ 888/745-7272 (888-PIK-P2P2)

Illinois Environmental Protection Agency
Office of Pollution Prevention
⇨ 217/782-8700

Indiana Dept. of Environmental Mgmt.
Office of Pollution Prevention
⇨ 317/232-8172

Michigan Dept. of Environmental Quality
Environmental Assistance Division
⇨ 800/662-9278

Minnesota Technical Assistance Program
⇨ 612/624-1300

Ohio Environmental Protection Agency
Office of Pollution Prevention
⇨ 614/644-3469

Wisconsin Dept. of Natural Resources
Cooperative Environ. Assistance
⇨ 608/267-9700

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